ICE -OCEAN FOUR DIMENSIONAL STRUCTURE AND DYNAMICS

Annual Technical Report for The Period
31 March 1994 to 31 March 1995

Project Title: Ice-Ocean Four Dimensional Structure and Dynamics
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OBJECTIVES

To understand the relationship among underice morphology, ice thickness and the structure of the oceanic boundary layer, an Autonomous Oceanographic Sampling Network is being developed. The purpose of the network is to provide a technique for spatially adaptive sampling capable of resolving evolving gradients with sparsely distributed sensors. Each network consists of a base buoy and a number of Autonomous Oceanographic Vehicles (AUVs) at fixed levels. The base buoy serves as a navigation beacon, energy source, telemetry link and surface sensor platform. Each AUV functions as a subsurface sensor platform, short term data logger and programmable, navigable vessel. The first step has been to use an AUV to define acceptable performance as a subsurface platform, to implement and evaluate schemes/systems for homing and docking with the base buoy, and to conduct tests of the data and power transfer interfaces.

APPROACH

The most immediate task has been the acquisition/development of a vehicle that can serve as the test AUV. Therefore, this phase of the work has been to develop a platform that will meet a limited number of the desired AUV functions in order to evaluate and test homing systems, required AUV performance during homing and docking, and power and data interface systems. A prototype vehicle has been previously constructed and work during this period has focused on testing of the prototype AUV and of docking and homing systems. These tests include vehicle response to control system inputs and evaluation of control system and vehicle dynamics to provide suitable docking capability. It also includes development of appropriate sensor suits, data acquisition and storage systems necessary to record AUV performance during homing/docking, and integration of these systems into the vehicle payload. Finally, docking and interface connections to a suitable buoy system, consisting of data up-links and power transfer for recharging were to be designed constructed and evaluated.

ACCOMPLISHMENTS

The major effort during this period has been to develop a methodology for testing AUV performance and homing system operation and to conduct the initial testing of these systems. The present AUV prototype is a 28 cm dia (10.75 inch) cylindrical shape with an overall length of 1.6 m (5.25 ft). The payload consists of an onboard computer, data acquisition and storage system, and sensor interface. The initial sensor payload has been primarily sensors to measure vehicle performance, and data acquisition has been focused on recording the output from these sensors. Therefore, the primary use of the system is used to measure and record vehicle performance during homing and docking. Currently the initial testing of the AUV has been completed and preliminary data during the docking phase have been obtained. Parameters sensed and recorded during AUV/Homing performance evaluation are:

1. AUV magnetic heading and deviation from a desired heading.
2. Control system inputs to horizontal control system
3. Gyro stabilized rate of turn
4. Depth and rate of change in depth
5. Control system input to vertical control system
6. Thrustor power
7. Battery power consumption

As stated above, the testing to date has been on AUV performance during the homing and docking phase, and systematic testing of a magnetic homing system. The magnetic homing system is presently believed to be the best candidate for homing and is being integrated into the AUV and a prototype dock system. This magnetic homing system has been constructed and fully tested and debugged in land based trials. Based on these land tests, and on preliminary AUV tests the design has been revised and a second generation constructed and incorporated into the preliminary underwater dock system. The AUV and homing system underwent three tests in the summer of 94. Parameters sensed and recorded during these tests were (in addition to 1-7 above) were:

8. AUV speed
9. Range from the dock.
10. Direction from the dock
11. Vehicle angle to the dock.
12. Angle and rate of change of angle between the actual angle and that required for successful docking.

As mentioned, there were three tests in the summer of 1994 to evaluate AUV response during homing, and the homing system itself. Surface testing demonstrated adequate AUV response, and homing system operation and accuracy. Consistent homing was achieved during surface testing. Subsurface testing was limited as the AUV buoyancy and vertical control systems had to be modified. Preliminary subsurface tests of the magnetic homing system were satisfactory. Subsequent to the subsurface tests, the magnetic homing system has been further refined. In addition, modification of the inductive coupling systems for data and power transfer have also been modified.

PERSONNEL

The work as NCSU has been performed by the PI and one MS graduate student, James Jewell. Mr. Jewell completed the MS degree in June 94. Mr. John Ring, who started the MS degree in Mechanical and Aerospace Engineering in Spring 94 has worked on the project until Dec. 95. Subsequent work has been delayed because of the curtail in funding (c.f. budget & progress). The electronic circuit design and much of the sensor interfacing have been done by Electronic Design Consultants, under a sub-contract from NCSU. The principal investigator for the sub-contract to Electronic Design Consultants is Dr. Michael D. Feezor. In addition, Electronic Design Consultants has also supported a field technician, Mr. Paul Blankenship, who has provided the lead in planning and carrying out the recent field experiments. Both have added a necessary and different perspective to the overall program. We continue to have a very good working relationship with Electronic Design Consultants, and plan on using them to provide a major part of the work in the future.

BUDGET & PROGRESS

The funding for the last two years has been at approximately one-half the level requested in the original award. This funding has allowed what we believe to be reasonable progress, as indicated above. However, beginning in fall 95 progress was considerably slowed. This is particularly true in the field testing, which is one of the more expensive tasks. This has necessitated a revision in the tasks and objectives for the project. A new proposal was submitted on 1 April, which indicates these plans and the requested funding.